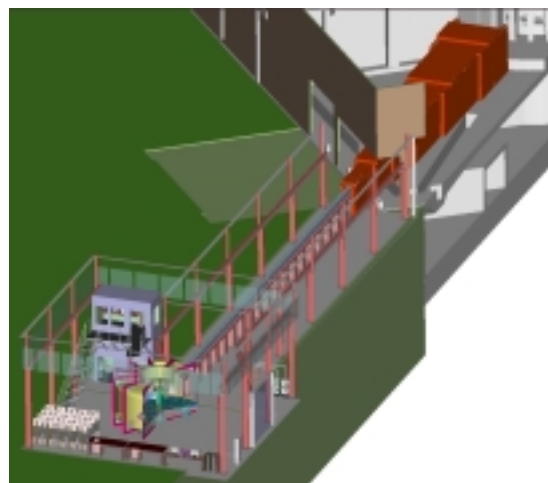


# Backscattering Spectrometer

For more information contact Ken Herwig, kherwig@anl.gov, 630-252-5371

**The backscattering spectrometer is intended for study of atomic scale dynamics at high resolution – diffusive and vibrational motions of adsorbed molecules or large molecules.**

The Backscattering spectrometer is designed to provide extremely high energy resolution near the elastic peak, enabling studies of the diffusive dynamics of molecules (quasielastic scattering). This instrument features very high flux and a dynamic range in energy transfer that is approximately 5 times greater than available on comparable instruments today. In addition, the instrument provides the unique capability of shifting the incident neutron bandwidth enabling inelastic scattering to 18 meV of energy transfer with a resolution of 0.1% of the energy transfer.



Moderator	decoupled poisoned supercritical hydrogen
Beam line	2
Source-sample	84 m
Sample-analyzer crystal	~2.5 m
Analyzer crystal-detector	~2.2 m

	<u>Si 111</u>	<u>Si 311</u>
Elastic energy	2.08 meV	7.64 meV
Band width	$\pm 258 \mu\text{eV}$	$\pm 1700 \mu\text{eV}$
Resolution (elastic)	2.2 $\mu\text{eV}$	10 $\mu\text{eV}$
Q-range (elastic)	$0.1 \text{ \AA}^{-1} < Q < 2.0 \text{ \AA}^{-1}$	$0.2 \text{ \AA}^{-1} < Q < 3.8 \text{ \AA}^{-1}$
Solid angle	1.45 steradians	1.45 steradians

**No existing instrument provides all these capabilities!  
Factor of 30-100 faster than existing instruments where capabilities overlap!**

## Si 111

- Quasielastic Scattering –
  - Translational Diffusion (self diffusion coefficients as low as  $10^{-7} \text{ cm}^2/\text{sec}$ )
  - Rotational Motions (correlation times to 100's psec)
- High Intensity enables
  - Parametric Studies (~ 15 minutes/data set)
  - Very Small Samples ( $< 10^{-4}$  moles H-atoms)
    - High Pressure
    - High Temperature
    - Shear (1 micron thick hydrogenous samples)
  - Dilute Systems
  - Weakly Scattering Isotopes
- Unique Dynamic range enables detailed lineshape analysis, more sophisticated modeling of the diffusive dynamics
- Science Examples
  - Macromolecule Dynamics, biomolecules and polymers

- Solvent Dynamics, e.g. nanometer scale reverse micelles
- H-diffusion in metallic nanoparticles
- Ion diffusion in ionic conductors
- Quantum Tunneling
- Dynamics of interfacial films, lubricating molecules

## Si 311

- Quasielastic Scattering –
  - Translational Diffusion (self diffusion coefficients as low as  $2 \times 10^{-6} \text{ cm}^2/\text{sec}$ )
  - Rotational Motions (correlation times to 100 psec)
- Extended Q-range coupled with high energy resolution enables
  - Detailed studies of rotational-translational coupling, e.g. in water
  - Studies of the Q-dependence for coherently scattering samples

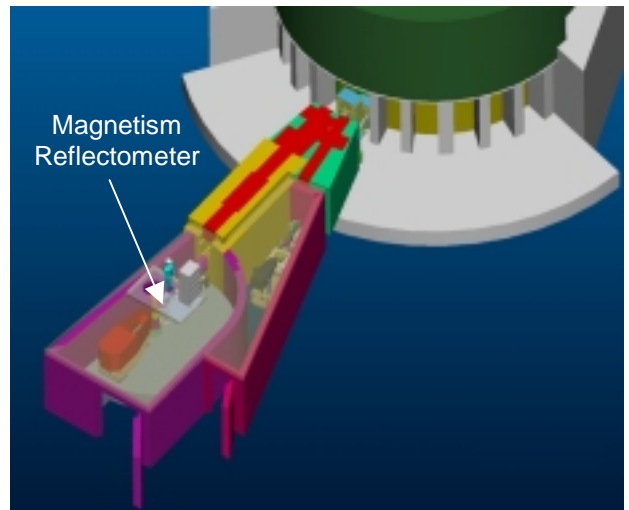
# Magnetism (Vertical Surface) Reflectometer

For more information contact Frank Klose, [fklose@anl.gov](mailto:fklose@anl.gov), 630-252-7468

## Magnetic and chemical density profiles in surfaces, thin films and multilayer systems

The SNS Magnetism Reflectometer will be a highly demanded instrument focused on investigations of nanostructures. Its main task is the characterization of buried magnetic interfaces and magnetic particles. The polarized beam capability is also an important means for investigations on non-magnetic systems. The instrument will have in-situ thin film preparation/manipulation capabilities to make use of the *atomic engineering by design* concept, one of the most promising areas in nanotechnology.

Moderator	coupled supercritical hydrogen
Beam line	4a
Source-sample distance	17.5 m
Sample-detector distance	0.5 – 2 m
Detector size	$20 \times 20 \text{ cm}^2$
Detector resolution	1.5 mm
Polarized beam and polarization analysis	



Bandwidth  
Wavelength range  
Q range  
Minimum reflectivity

$$\begin{aligned}\Delta\lambda &= 3.5 \text{ \AA} \\ 1.8 \text{ \AA} < \lambda < 14.0 \text{ \AA} \\ 0 \text{ \AA}^{-1} < Q < 7.0 \text{ \AA}^{-1} \\ &\approx 10^{-10}\end{aligned}$$

Factor of 10-100 times higher data rate than best existing instrument!  
Factor of 10 lower reflectivities than currently possible!

- Layer-averaged chemical and magnetic depth profile for thicknesses of 5 Å -10,000 Å
  - Magnetic moment formation in thin films
  - Interface polarization, interfacial coupling and quantum confinement
  - Prototypes of new hard and soft magnetic materials to improve the efficiency of energy delivery systems (e.g., motors, transformers, etc.)
  - Magnetic recording media and magnetic sensors
  - Giant and colossal magnetoresistance
  - Flux penetration and flux-lattice ordering in superconductors
  - Molecular magnets
- Depth-dependent studies of chemical and magnetic lateral structures using grazing-incidence small-angle scattering (GISANS) and in-plane diffraction
  - Nucleation and growth of structured surfaces
  - Magnetic domains and patterned structures of magnetic dots for potential storage technologies (magnetic recording techniques are approaching fundamental limits, which requires investigation of new basic ideas like dots, lines, anti-dots)
  - Self-assembled layers and integrated materials such as polymers combined with magnetic materials
  - Nanoparticles, spin glasses, amorphous/polycrystalline films
- Unique capabilities
  - Ultra-high intensity for in-plane diffraction and off-specular / GISANS measurements
  - Combination of reflectometry and high-angle diffraction  
=> unique capability to resolve large-scale and nanoscopic structural/magnetic features at the same time
  - Time-dependent studies (pulsed magnetic, electric, light or other fields)
  - In-situ structural or magnetic phase-diagram determinations (temperature, pressure, atmosphere, magnetic field, ...)
  - Structural and magnetic in-situ studies on ultrathin films in an ultrahigh vacuum environment

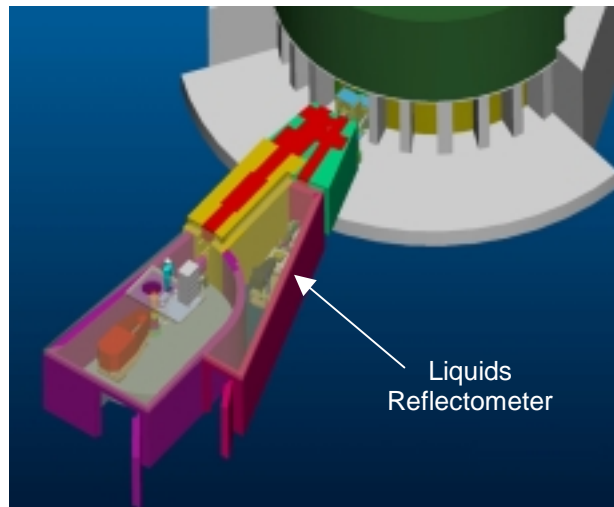
# Liquids (Horizontal Surface) Reflectometer

For more information contact John Ankner, jankner@anl.gov, 630-252-6408

## Density profiles normal to the surface at liquid surfaces and liquid interfaces

The SNS Liquids Reflectometer is optimized for the study of interfaces where gravity plays an essential part. A primary focus is the study of interfacial behavior at liquid surfaces, so the instrument is optimized to study samples where the surface must be horizontal. Because of the focus on liquid interfaces, careful attention is also paid to vibration isolation to prevent surface ripples from interfering with the measurements.

Moderator	coupled supercritical hydrogen
Beam line	4b
Source-sample distance	13 m
Sample-detector distance	1.5 m
Detector size	$25 \times 25 \text{ cm}^2$
Detector resolution	1.5 mm



Bandwidth  
Wavelength range  
Q range (air/liquid)  
Q range (air/solid)  
Minimum reflectivity

$$\begin{aligned}\Delta\lambda &= 4.5 \text{ \AA} \\ 1.8 \text{ \AA} &< \lambda < 13.6 \text{ \AA} \\ 0 \text{ \AA}^{-1} &< Q < 0.5 \text{ \AA}^{-1} \\ 0 \text{ \AA}^{-1} &< Q < 2 \text{ \AA}^{-1} \\ &\approx 10^{-10}\end{aligned}$$

Factor of 10-100 times higher data rate than best existing instruments!  
Factor of 10 lower reflectivities than currently possible!

- Layer-averaged chemical depth profiles for thicknesses of 5 – 10,000 Å for gas/liquid, gas/solid, liquid/solid, and liquid/liquid interfaces
  - Complex fluids under flow
  - Reaction kinetics
  - Interfacial structure in drug delivery systems
  - Diffusion of complex molecules
  - Critical phenomena in fluid systems
  - Catalytic surfaces and electrochemistry
- Depth-dependent studies of lateral structures using grazing-incidence small-angle scattering (GISANS) and off-specular scattering
  - Phase separation in polymer films
  - Inorganic templating at air/water interfaces
  - Vesicles and gels
  - Surfactants at interfaces
  - Membranes and their intermolecular interaction
  - Protein adsorption
  - Self-assembled monolayers
- Unique capabilities
  - High intensity for off-specular/GISANS measurements
  - Time-dependent studies (e.g. pulsed electric fields, pressure, temperature, kinetics)
  - Parametric studies (e.g. temperature, pressure, pH) for phase-diagram mapping

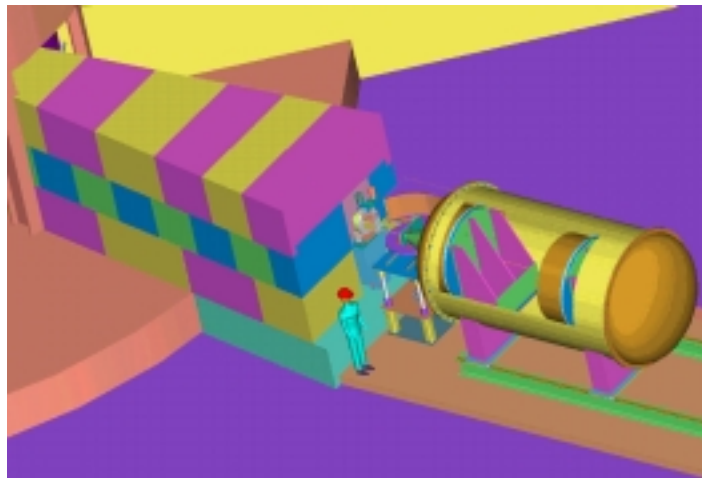
# Extended-Q SANS

For more information contact Jinkui Zhao, zhaoj@ornl.gov, 865-574-0411

**Large-scale structures in a variety of materials, including biological molecules, polymers, colloidal systems.**

The Extended Q-range Small Angle Scattering Diffractometer is designed to cover an unprecedented range in Q space. It will also have very high intensity and wavelength resolution. The instrument is optimized for studying complex systems that require data collection at low and high Q simultaneously.

Moderator	coupled supercritical hydrogen
Beam line	6
Source-sample distance	14 m
Low-angle detector	
Sample-detector distance	1 – 4 m
Detector size	1 m × 1 m
Detector resolution	5 mm
High-angle detector	
Sample-detector distance	1 m
Angular coverage	~35° - 150°
Detector resolution	5 mm



Bandwidth

Q Range

Integrated flux on sample

3.5-4.3 Å  
 $0.004 \text{ Å}^{-1} < Q < 12 \text{ Å}^{-1}$   
 $\sim 10^8 - 10^9 \text{ n/cm}^2/\text{s}$

**Much broader Q range than best existing instruments!**  
**Factor of 10 more intense than best existing instrument at same Q range and  $\delta Q$ !**

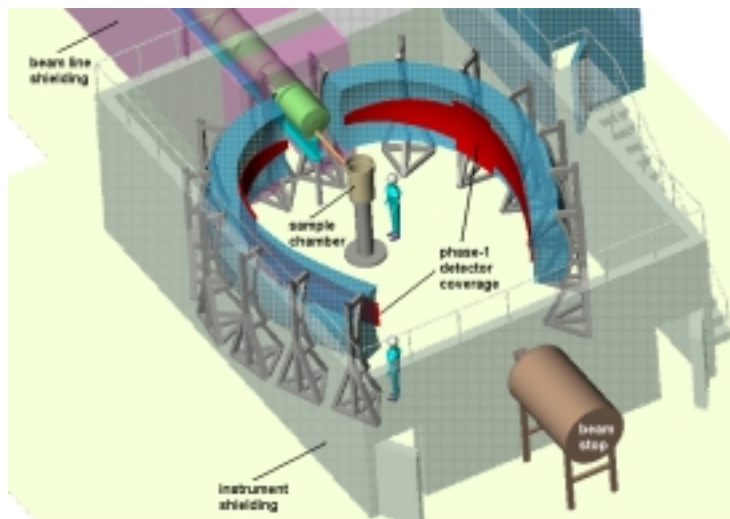
- Life Science
  - Solution structures of protein, DNA and other biological molecules and molecular complexes
  - Protein-protein, protein-ligand interactions, kinase regulation
  - Protein-membrane interaction
- Polymer and Colloidal Systems
  - Block copolymers
  - Micelles
  - Micro emulsions
  - Polyelectrolytes
  - Electric double layer and ion distribution at solid-liquid interface
  - Dendrimers
  - Aerosols
- Material Science
  - Simultaneous study of domain and crystalline structures
  - Crystallization and precipitation
  - Nanoparticles
- Earth and Environmental Sciences
  - Pore structure in soil
  - Mechanism of absorbing contaminants by soil
  - Fractal structure of rocks

# Powder Diffractometer

For more information contact Jason Hodges, [hodges@anl.gov](mailto:hodges@anl.gov), 630-252-9761

## Atomic structure in a wide variety of powdered crystalline samples

This will be an extremely flexible and versatile general purpose diffractometer useful for a wide range of structural studies. It can cover d-spacings from  $\sim 0.5$  Å or less to well over 40 Å in a single measurement, and is capable of collecting typical Rietveld statistics in  $\sim 20$  minutes from a  $0.6 \text{ cm}^3$  sample with a  $< 0.1\%$  resolution at short d-spacings and  $< 1\%$  resolution for nearly all d-spacings of interest. Alternatively, much of this resolution can be traded for intensity, making it possible to make measurements in  $\sim 1$  minute. Instrument features allow the users great latitude to optimize the data range, resolution, and statistical precision for each particular experiment.



Moderator	decoupled poisoned supercritical hydrogen
Beam line	11a
Source-sample distance	60 m
Sample-detector distance	1 – 6 m
Detector angular coverage	$6^\circ < 2\theta < 170^\circ$
Wavelength bandwidth	$\sim 1$ Å

Frame 1

Frame 6

Resolution

Resolution at  $90^\circ$

$0.3 \text{ Å} < d < 10 \text{ Å}$

$3 \text{ Å} < d < 66 \text{ Å}$

$0.001 < \delta d/d < 0.016$

$\delta d/d = 0.0015$

Very flexible!

Data for precise refinements of complex structures obtained in  $\sim 10$  min!

Can study very small samples!

Experiments performed on this diffractometer will

- investigate structural response of materials to changing applied conditions and
- elucidate magnetic and non-magnetic crystal structures with unprecedented precision and speed.

The areas of interest include:

- Magnets
  - high- $T_c$  superconductors
  - colossal magnetoresistive perovskites
  - metal-insulator transitions
  - charge and orbital ordering transitions
  - molecular magnets
  - frustrated and spin-glass magnets
  - heavy fermions
  - spin fluctuators
  - permanent (large and fine particle) magnets
- Non-Magnets
  - Zeolite and AIPO frameworks
  - ionic conductors
  - fuel cell, battery and sensor materials
  - gas-hydrates
  - metals and semiconductors
  - dielectrics and ferroelectrics
  - negative thermal expansion
  - complex dehydroxylation mechanisms
  - cements
  - pharmaceuticals
  - minerals

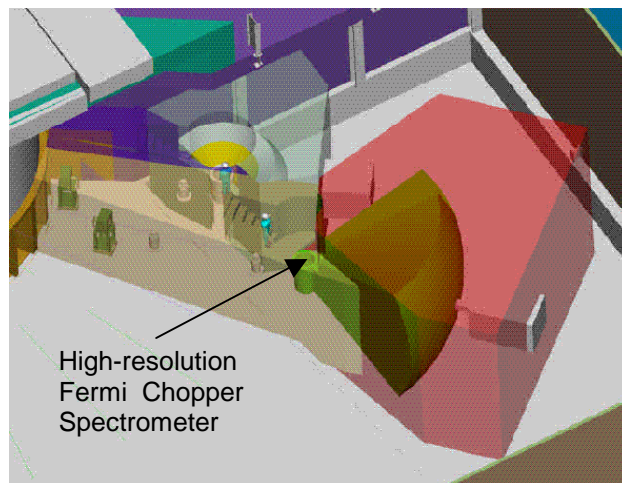


# High-resolution Fermi Chopper Spectrometer

For more information contact Doug Abernathy, [dabernathy@pns.anl.gov](mailto:dabernathy@pns.anl.gov), 630-252-6752

## Atomic-scale dynamics at thermal and epithermal energies – optimized for resolution

The high-resolution Fermi chopper spectrometer is optimized to measure details of the inelastic scattering from single crystals, particularly for magnetic systems. By integrating sample motions and the highly pixelated detector array, sophisticated data acquisition and visualization software will acquire and display data rapidly and allow the experimenter to choose the cuts through the data to accentuate the desired features of the sample response. The long incident and secondary flightpaths give resolution in  $Q$  and  $E$  comparable to or better than typical triple-axis spectrometers, and the instrument can operate with incident energies from 15 - 1000 meV with 1.5% resolution.



Moderator	decoupled poisoned water	
Beam line	17	
Source-sample distance	17.5 m	
Sample-detector distance	6 m	
Angular coverage - low angle	$-25^\circ < 2\theta < 35^\circ$ horizontal $\pm 30^\circ$ vertical	
- high angle	$35^\circ < 2\theta < 60^\circ$ horizontal $\pm 10^\circ$ vertical	
Detector solid angle	1.2 steradians	

<u><math>E_i</math> (meV)</u>	<u><math>\delta E/E_i</math> (%)</u>	<u>flux-on-sample (n/cm<sup>2</sup>/s)</u>
1000	1.5	$0.6 \times 10^5$
	5	$3.7 \times 10^5$
50	1.5	$1.4 \times 10^5$
	5	$8.2 \times 10^5$

More than twice the detector solid angle coverage of comparable instruments!  
Integrated sample motions and pixelated detector array are ideal for single crystal spectroscopy!

The high resolution Fermi chopper spectrometer, with its capability to acquire data quickly and relate it to three-dimensional momentum transfers, will allow new studies on single crystals and novel systems:

- High temperature superconductivity - spin dynamics in superconductors and precursor compounds, incommensurate spin fluctuations at varying doping levels
- Highly dispersive excitations, as found in high  $T_c$  materials, where lower  $Q$  resolution instruments would integrate out important information
- Model magnetic systems, such as one-dimensional spin chains and spin ladders, and crossover effects from 1D to 3D magnetism
- Excitations in quantum fluids, quantum critical phenomena and non-Fermi liquid systems
- High resolution crystal field spectroscopy reaching into the 1 eV range
- Coupling of electronic and spin systems in correlated-electron materials
- Colossal magnetoresistive materials

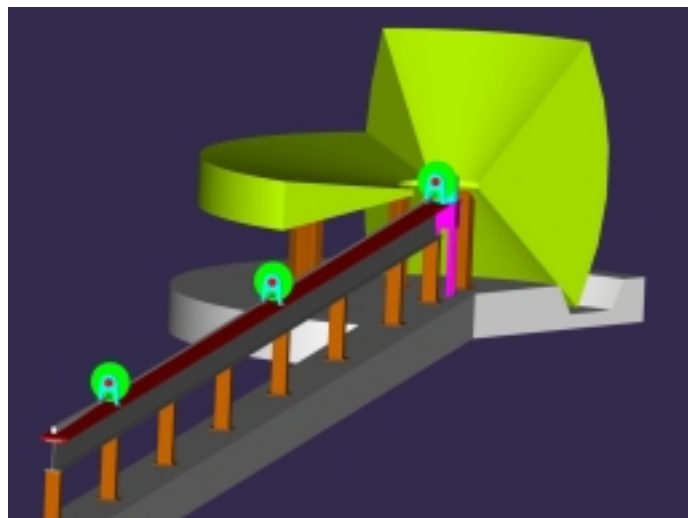
# 10-100 Microvolt Multi-Chopper Spectrometer

For more information contact Garrett Granroth, ggranroth@anl.gov, 630-252-9884

## Atomic-scale dynamics in the 0-20 meV energy range

This spectrometer will provide ~10 times finer energy resolution with 100-1000 times more neutrons on sample than current disc chopper instruments. Disc chopper instruments are already well known for their flexibility in energy resolution of 10-100  $\mu\text{eV}$ , and for the large Q range provided by a wide detector area. A broad range of science, spanning many different disciplines, will benefit from the flexibility, energy resolution, and flux of this instrument. In particular, the increased flux provides the ability to perform many experiments in dilute samples and confined geometries.

Moderator	coupled supercritical hydrogen
Beam line	5
Source-sample distance	42 m
Sample-detector distance	5 m
Angular coverage	$\pm 30^\circ$ horizontal $\pm 30^\circ$ vertical
	1 bank extending to $150^\circ$



<u><math>E_i</math> (meV)</u>	<u><math>\delta E/E_i</math> (%)</u>	<u>flux-on-sample (<math>\text{n}/\text{cm}^2/\text{s}</math>)</u>
30	3	$1 \times 10^6$
	10	$1 \times 10^7$
2	3	$7 \times 10^5$
	10	$5 \times 10^6$

Very flexible – general purpose!  
Factor of ~100 more flux on sample than any other disk chopper spectrometer at the same resolution and energy transfer!

- Complex fluids
  - Dynamics of dilute protein solutions
  - Diffusion in biological gels
  - Selective absorption of molecules on surfaces
- Quantum Fluids
  - Excitations of quantum fluids in confined geometries
- Magnetism
  - Quantum effects in low dimensional systems near the saturation magnetic field
  - Scaling studies of magnetic excitations in non fermi liquids
  - Magnetic excitations in molecular magnets
  - Magnetic excitations in disordered magnets
- Dynamics of water
  - Diffusion in confined geometries
  - Dynamics in confined geometries
  - Relaxation dynamics of water of hydration in cement
- Chemical spectroscopy
  - Inter and Intra molecular dynamics
  - Dynamics of ions trapped in confined geometries

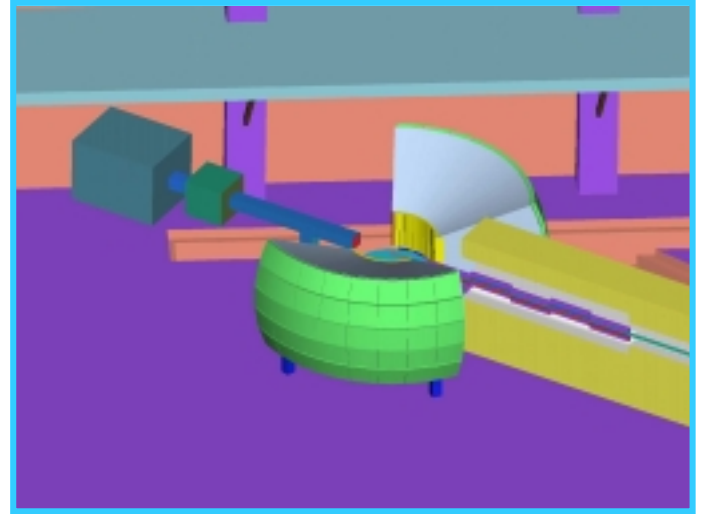
# Engineering Materials Diffractometer

For more information contact Xun-Li Wang, [wangxl@sns.gov](mailto:wangxl@sns.gov), 865-574-9164

## Internal strain and texture in engineering samples

This instrument is designed to tackle a variety of problems in materials science and engineering, ranging from the determination of residual stress in engineering components to understanding the fundamental aspects of materials behaviors during processing and use. To provide this breadth of performance the instrument includes an integrated load frame and other equipment for handling large engineering samples, and an integrated small-angle detector to permit simultaneous measurement of diffraction and SANS.

Moderator	decoupled poisoned water
Beam line	9
Source-sample distance	44 m
Sample-detector distance	1.5 – 3 m
Detector angular coverage	$60^\circ < 2\theta < 150^\circ$
Wavelength bandwidth	$\sim 1.3 \text{ \AA}$



Gauge volume

3D strain mapping  
1D strain mapping

$1 \text{ mm}^3$

0.1 mm

Resolution

$0.002 < \delta d/d < 0.006$

3D strain mapping in 2 minutes per position!  
Strains from in-situ loading measured in 1 minute!  
Simultaneous diffraction and small-angle scattering!

- Stress mapping in components
- Characterization of the metallurgical changes due to welding
  - effect of phase transformation
  - influence of precipitation
  - effect of recrystallization and recovery
  - development of microvoids and cavities
  - correlation between microstructure and residual stress
  - joining of dissimilar material
- In-situ measurements of recrystallization kinetics of deformed specimens
  - mechanisms of nucleation and growth
  - effect of grain-orientation dependent residual stress due to multi-axial deformation
  - effect of grain size
  - stored energy
- In-situ measurements of the intergranular stress
- Determination of residual stress due to surface engineering
- In-situ, real time study of phase transformations and chemical reactions, including precipitation and spinodal decomposition during simulated processing
- The development of strains during the actual welding operation
- Effect of high cycle fatigue on the residual stress in components
- Examining the *response of a component loaded in-situ* on the diffractometer
- Casting and solidification science

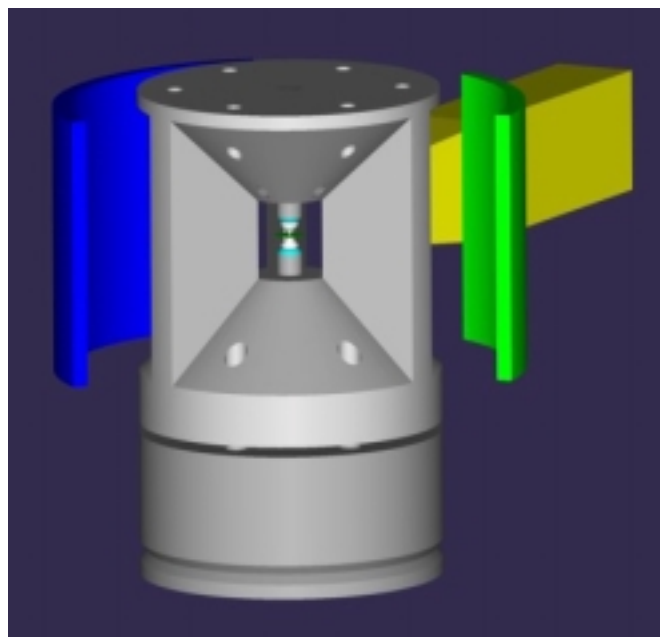


# Ultra-High-Pressure Diffractometer

For more information contact Chris Tulk, [ctulk@anl.gov](mailto:ctulk@anl.gov), 630-252-9881

## Atomic structure at pressures up to 100 Gpa

Designed primarily for diffraction studies of materials under extreme conditions of pressure and temperature, the UHP-diffractometer will significantly extend the achievable pressure range and consequently the region of phase space that is accessible for material studies using neutron beams. The high SNS flux, coupled with novel larger-volume opposed-anvil high pressure cells under development at the *Geophysical Laboratory* at the *Carnegie Institution of Washington*, will allow efficient data collection from very small samples. This unique cell design permits large detector solid angle coverage.



Moderator	decoupled poisoned supercritical hydrogen
Beam line	1a
Source-sample distance	15 m
Sample-detector distance	37 cm
Angular coverage	38-142°, 98-150° horizontal ±34° vertical

Pressure cell removable for sample loading  
Potential for very large press downstream from normal sample position

~5 times the highest pressure of current neutron diffractometers!  
~200 times the intensity of current high pressure neutron diffractometers!

Examples of science using the SNS UHP-diffractometer include:

- Hydrogen at brown dwarf conditions
- The elastic anisotropy of  $\epsilon$ -iron at Earth core conditions
- Real-time *in-situ* monitoring of 'real rocks' as an analogue to the down going slab in the subduction context
- Planetary ices; the structure and strength of ices under pressure (proof-of-principle experiments now underway at ISIS in the UK)
- Silicate melts, glasses at high P and T and the dynamical changes occurring during heating and pressurization
- Strength and rheology of materials and the relationship to brittle and ductile failure, including stress release as a function of time (the stress rheology in the mantle)
- The structural changes accompanying transitions in Fullerenes and their derivatives
- The structures of supercritical fluids and liquids
- Hydrogen bonding in organic and inorganic systems as a function of P and T, including liquids.

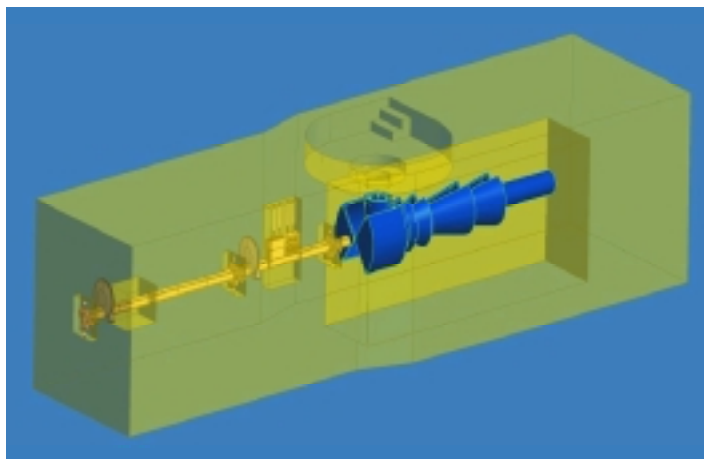
# Disordered Materials Diffractometer

For more information contact Chris Tulk, ctulk@anl.gov, 630-252-9881

Small-angle scattering from liquids and glasses, with higher resolution capability for analysis of disorder in crystalline materials

The SNS disordered materials diffractometer is designed to be a high flux, medium-to-high resolution diffraction instrument that is primarily used to study the short to medium range structure in largely disordered systems. Length scales probed cover a large range from local, short range atomic/molecular order of a few angstroms to intermediate range order including interatomic correlations and networks in glasses and on to mesoscopic dimensions of 10's of nanometers that include surfactant ordering, protein folding and liquid crystals

Moderator	decoupled poisoned supercritical hydrogen
Beam line	10
Source-sample distance	15 m
Sample-detector distance	0.4 - 4.0 m
Angular coverage	1-150° horizontal 6.5 steradians



Q range  
Resolution

0.015 - 100 Å<sup>-1</sup>  
0.25% - 5%

~20-30 times more intensity than best current instruments for study of structure in disordered materials!

Some examples of high impact science possible with the SNS disordered materials diffractometer include:

- Intermolecular hydrogen-hydrogen structure in polymers using H-D substitution for direct determination of intermolecular H-H structure,
- Role of water in biological macromolecules such as globular proteins,
- Meta-stabilization of nanoscale materials with nonlinear optical activity,
- Pair distribution function analysis of disordered materials including superconducting cuprates, semi crystalline polymers and nanocrystalline particles,
- Super-ionic glasses where some ionic species are mobile within an otherwise frozen glassy network, and,
- Structural properties relations in transition metal oxides.

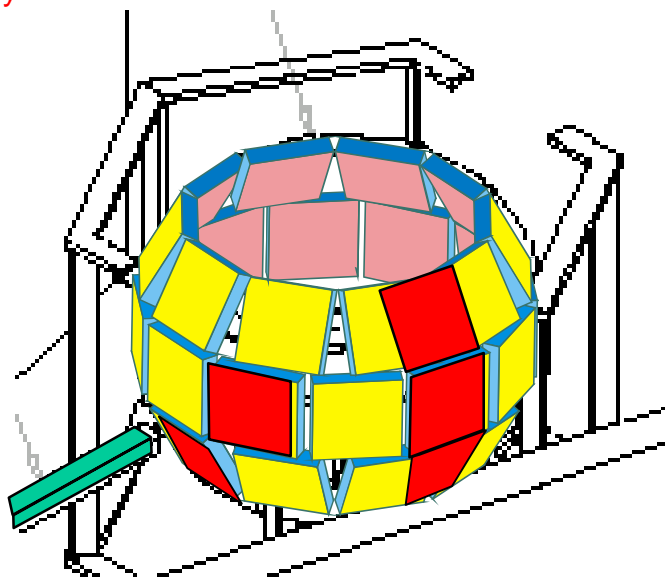
# Single Crystal Diffractometer

For more information contact Christina Hoffmann, [choffmann@anl.gov](mailto:choffmann@anl.gov), 630-252-9885

## Atomic structure in moderate-unit-cell single-crystal samples – possibly also useful for protein crystallography

The proposed instrument with a large coverage of reciprocal space will measure a full single crystal pattern of low symmetry in one setting, leading to much shorter measurement times than achievable with current instruments. The single crystal diffractometer is optimized for structure solution and refinement from small single crystals of inorganic materials, organic molecules, proteins important for bio-organic or medical research. Specific sample environments for low/high temperature, high pressure, vacuum, and inert gas environments are planned.

Moderator	decoupled poisoned supercritical hydrogen
Beam line	12
Source-sample distance	TBD
Sample-detector distance	TBD
Angular coverage	TBD



Design goal is full structural measurement from 1 mm<sup>3</sup> crystal of moderate unit cell size in a few minutes.

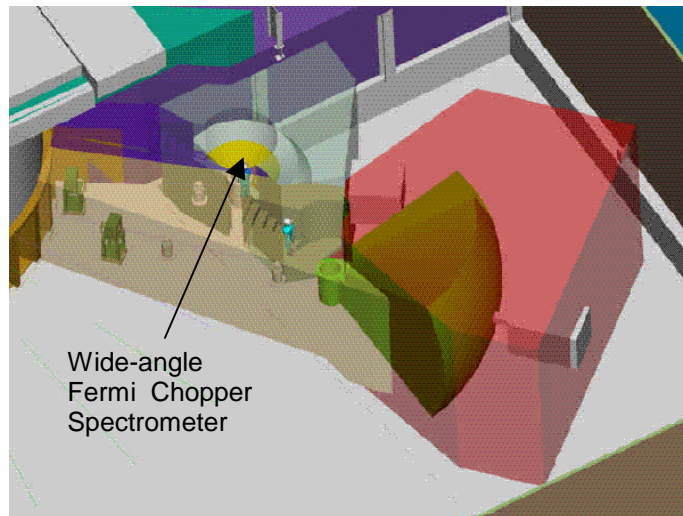
- Accurate inorganic structures of materials for technical applications like superconductors, porous materials (zeolite-like materials) and functional materials will be determined.
- Accurate structure determination of inorganic materials and organo-metallics used for enantiomorphic / enantiospecific synthesis.
- Structure determination of the whole crystallographic structure -including hydrogen atom locations in organic molecular and bio-/organic materials. In proteins and organic molecules the hydrogen bonds play an important role in understanding the molecular stability/reactivity and inter-molecular interactions.
- Single crystals with disordered and defect structures like oxide super conductors.
- Disordered minerals with statistical and/or dynamical disorder due to energetically equivalent atomic sites, Jahn-Teller effect.
- Layered cement(-like) minerals exhibiting stacking faults along the layer axis including inter layer cations.
- Disordered structures of porous materials – organic and inorganic - with guest-host interactions; structures with cavities and channels that allow transport mechanisms and kinetics to be studied. In-situ measurements at different temperatures and pressures.
- Organic disordered materials, *i.e.* buckminster fullerenes with rotational disorder.
- Quasi crystals with five fold symmetry.
- Diffuse scattering (thermally induced disorder, disorder resulting from defect impurities, or the structure of short range magnetically ordered systems)
- In-situ measurements of kinetics and structural changes for example temperature dependent dehydration mechanisms, pressure dependent dis-/ordering phenomena in layered or porous channel structures; twinning mechanisms introduced by temperature and pressure changes.
- Phase transitions (including changes of symmetry, and superlattice reflections)
- Incommensurate structures (*i.e.* mullite / mullite-like ceramics)Magnetic materials; also in-situ measurements of changes in different magnetic fields.

# Wide-angle Fermi Chopper Spectrometer

For more information contact Doug Abernathy, dabernathy@anl.gov, 630-252-6752

## Atomic-scale dynamics at thermal and epithermal energies - optimized for angular coverage

The wide-angle Fermi chopper spectrometer uses a detector coverage of  $\pi$  steradians to provide extreme sensitivity for inelastic scattering with a moderate energy resolution of 2 - 5% in the incident energy range of 10 - 1000 meV. Neutron guides will enhance the flux delivered to the sample by as much as a factor of 10 at lower energies as well. Motorized sample motions and the highly pixelated detector array will allow parametric studies of powders and single crystals in a wide range of Q and E. Experiments with novel materials will also be possible because smaller sample volumes can be measured.



Moderator	decoupled poisoned water
Beam line	18
Source-sample distance	13.5 m
Sample-detector distance	2.5 m
Angular coverage	$-40^\circ < 2\theta < 140^\circ$ horizontal $\pm 30^\circ$ vertical
Detector solid angle	3.1 steradians

<u><math>E_i</math> (meV)</u>	<u><math>\delta E/E_i</math> (%)</u>	<u>flux-on-sample (n/cm<sup>2</sup>/s)</u>
1000	3	$1.3 \times 10^5$
	5	$3.0 \times 10^5$
50	3	$3.7 \times 10^5$
	5	$7.5 \times 10^5$

Inelastic spectrometer optimized to cover a broad range in Q and E.  
Massive detector coverage and neutron guides enhance sensitivity for smaller samples and parametric studies.

The increased sensitivity of the wide-angle Fermi chopper spectrometer compared to current instruments will offer new opportunities for scientific studies in:

### Lattice dynamics

- Entropy and the effects of vibrational modes on stability and phase transitions of solids
- Excitations in disordered materials; effects of nanoscale features on vibrational entropy and thermodynamic stability
- Equations of state from measurements of the phonon density of states as a function of temperature and pressure
- Phonons in correlated-electron materials; coupling of lattice and electronic degrees of freedom in high  $T_c$ , heavy-fermion and mixed valence materials

### Magnetic dynamics

- High temperature superconductivity - spin dynamics in superconductors and precursor compounds, crystal field spectroscopy
- Low dimensional systems; 1D quantum magnets and low-dimensional conductors
- Magnetism in actinide materials
- Heavy fermion magnetism and superconductivity
- Metal-insulator transitions in oxides

### Chemical Physics

- Deep inelastic neutron scattering studies of hydrogen
- Characterization of novel materials